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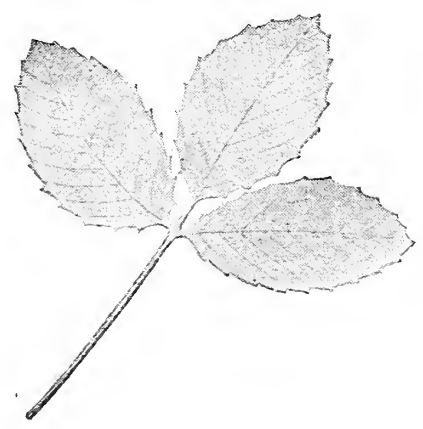
SWEET CLOVER

1916

AND

HOW TO GROW IT

BY
E. E. BARTON



Fourth Edition Revised and Enlarged

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PREFACE TO 1912 EDITION.

The first edition of this pamphlet was issued in February, 1911, and, being limited in number was soon exhausted. The second edition was revised and rewritten and issued in much larger numbers early in January, 1912, but was practically exhausted in six months, indicating an increasing interest among farmers and landowners in the subject of sweet clover. A large number of requests from foreign countries for copies indicates a world-wide interest in economic forage and soil-building leguminous plants. Many favorable comments on the pamphlet have come to the author's notice, both in correspondence and through the agricultural press, and he takes this opportunity to express his gratitude and appreciation. If by this means there is added some little to the interest taken in the value and importance of forage plants and soil fertility and maintenance, he will feel amply recompensed for recording here his observations and experience in growing sweet clover. The present edition gives to its readers the benefit of the latest researches on the subject of sweet clover and its cultivation.

THE AUTHOR.

Falmouth, Ky., November, 1912.

PREFACE TO 1916 EDITION.

"Sweet Clover and How to Grow It," first published in February, 1911, was the earliest treatise on the subject known to the author. Since then several excellent bulletins, some booklets and numerous pamphlets have appeared, adding much information of value and importance; and these, together with extensive notice in the agricultural press, have acquainted farmers fairly well in a general way with the plant. For these reasons in the present edition some of the matter in the earlier ones of a descriptive and historical nature has been omitted, and more discussion of methods of sowing and handling the crop has been added instead.

THE AUTHOR.

Falmouth, Ky., January, 1916.



CONTENTS.

	PAGE.
INTRODUCTION	vi

PART I. GENERAL OUTLINE.

SECTION.	PAGE.
1. Description	1
2. Origin	2
3. Distribution	2
4. Climate	3
5. Soils	3
6. Uses	3
7. Eradication	3
8. Plant Enemies	3
9. Plant Improvement	3
10. Principal Kinds Compared.....	4

PART II. HOW SWEET CLOVER IS UTILIZED.

FOR SOIL IMPROVEMENT—

11. Legume Crops	5
12. Nitrogen	5
13. Humus	5
14. Rotation Crop	6
15. Green Manure Crop.....	6
16. Winter Cover Crop.....	6
17. Orchard Cover Crop.....	6
18. Preventing Erosion	6
19. Soil Renovator	6
20. Preparation for Alfalfa.....	7
21. Choking Weeds	7
22. Increasing Land Values.....	7

AS FOOD FOR LIVESTOCK—

23. Useful Forage Crop.....	7
24. Nutritive Value	7
25. Palatability	9
26. Pasture	9
27. Hay	10
28. Ensilage	11
29. Soiling Crop	11
30. Catch Crop	11
31. BEE PASTURE	11
32. SEED CROP	11

PART III. CULTURAL METHODS.

SECTION.	PAGE.
SWEET CLOVER SEED—	
33. Selecting the Seed.....	13
34. Purity	13
35. Germination	13
36. Unhulled or Hulled Seed.....	14
37. Treated Seed	14
METHODS OF SOWING—	
38. How Sown	15
39. Sowing on Top the Ground.....	15
40. Covering the Seed.....	15
41. Double Seeding	16
42. Seed Bed	16
43. TIME OF SOWING.....	16
44. AMOUNT OF SEED.....	17
45. INOCULATION	18
46. NURSE CROP	19
47. TRANSPLANTING	19
LIME AND FERTILIZERS—	
48. Lime	19
49. Fertilizers	20
PASTURES AND MEADOWS—	
50. Pastures	20
51. Meadows	21
CONCLUSION	23
APPENDIX.....	24

INTRODUCTION.

The object of this pamphlet is to present the subject of sweet clover in a plain, practical way, and it is addressed in plain language to farmers and landowners who are interested in hay and pasturage and in restoring the fertility of the soil and maintaining it in a condition to supply the increasing wants of man and domestic animals.

It is intended to convey some information and useful suggestions on a subject with which the writer has had years of practical experience, and about which there is still some prejudices, some confusion and much misinformation notwithstanding the considerable amount of literature on sweet clover that has appeared within the last few years. What is said here about growing sweet clover applies mainly to the biennial kinds, which most concern the practical farmer; and while it is aimed to treat the subject in a reasonably thorough manner, it is impossible to cover all minute details within the scope of such a publication; and the time and manner of sowing and handling the crop may be modified, in the judgment of the farmer, to suit local conditions and particular needs.

SWEET CLOVER

PART I

GENERAL OUTLINE.

1. **Description.**—Sweet clover, as with other clovers, alfalfa, the beans, peas, vetches and numerous others, belongs to the family of plants called legumes; and through nodular bacteria developing on the roots, is able to gather nitrogen from the air for its own growth and for enrichment of the soil. Although called a clover, sweet clover and alfalfa are each classed as separate and distinct branches of the legume family. Instead of being like the clovers, sweet clover is more nearly akin to alfalfa, resembling the latter very closely in appearance and habits of growth during certain stages, as well as in food content or nutritive value. Alfalfa, sweet clover, burr clover and yellow trefoil constitute a group having the same species of nodular bacteria on their roots and possessing other features in common with each other.

Among the sweet clovers there are both annuals and biennials, the former living only one season and the latter continuing through two seasons and then dying. The plant is propagated only by the seed and never from the roots. But if allowed to mature, it reseeds abundantly, even when pastured, and continues from year to year much like a perennial.

During its early stages of growth sweet clover resembles alfalfa so closely that it is difficult to distinguish them apart; but on account of its greater vigor, in about two months sweet clover shows a ranker growth and possesses larger leaves and taller stems. The leaves are trifoliate or three-lobed, margins sharply toothed or serrate, dull green above and paler beneath. Each complete set of three leaves is joined to the stalk by a petiole, with a pair of slender bristle-like appendages (stipules) at the point of attachment. The shape of the leaves varies with the different stages of growth, but are generally oval or elliptical. In early summer of the second year's growth the leaves of the biennials are large and numerous, and oval to nearly round; but leaves developing later towards seeding time are small and lanceolate in form and few in numbers for so large a plant. Preparatory to blooming and bearing seed, the plant throws out long, lateral branches and the main stem shoots up to a height of four to eleven feet, and by the time it reaches full bloom the plant has lost most of its first leaves.

The seed are enclosed in close-fitting pods and borne on slender racemes. The blossoms are either white, yellow or purplish blue according to kind, and are typical legume flowers—that is, a perfect flower in which two of the petals are united and enclose the essential organs, stamens and pistil. It is probable that a large part, if not all of the seed of sweet clover is produced by cross-pollination through the medium of insects, especially honey bees.

The first two or three months after germination the root system consists principally of a taproot that reaches well into the subsoil for food and moisture. At this period the root is nearly or quite as long as the stem above ground.

Later the taproot becomes branched, and toward the end of the first season the roots of the biennial sweet clovers attain their maximum growth, reaching to a depth of fifteen to thirty inches, or more, and become thick and "fleshy" with the plant food stored up for starting the next season's growth. In the spring of the second year usually about ten to twenty new stalks or stems shoot up from each root crown, but often fifty or more.

Sweet clover obtains its name from a strong, distinct, sweetish fragrance of the flowers, also of the plant especially when drying, which is due to an ethereal oil it possesses, called "cumarin." Its botanical name is *Melilotus*, and in some localities this is used also as its common name.

Several Species.—There are a number of different species of sweet clover, but only three of them are common in the United States, and these are:

WHITE SWEET CLOVER (*Melilotus alba*).—Biennial; white flowers. Grows erect, 3 to 4 feet high first year, and 6 to 11 feet high second year, when it blooms and bears seed on slender racemes 3 to 12 inches long. Stems rather coarse, about half inch thick at the ground when matured.

BIENNIAL YELLOW SWEET CLOVER (*Melilotus officinalis*).—Biennial; yellow flowers. Grows erect 2½ to 3 feet high first year, and 4 to 5 feet high second year, when it blooms and bears seed on slender racemes 3 to 6 inches long. Stems are nearly as fine as alfalfa, seldom being a quarter inch thick at the ground when matured. Has a larger proportion of leaves and fine branches than the white; blooms and matures its seed crop evenly about three weeks earlier.

INDIAN SWEET CLOVER (*Melilotus indica*).—Annual; yellow flowers. In the Far West and Southwest it grows 12 to 16 inches high; in other sections of the country it seldom reaches more than 6 to 10 inches. Blooms and bears seed the first year, and dies out by the middle of the summer. Contains more of the bitter element and is locally called "sour clover" and "stink clover."

2. Origin.—Sweet clover is one of the oldest of known plants and its history reaches back into the dimness and obscurity of earliest times. It and alfalfa had a common origin or habitat in Northwest India and in Central or Western Asia, and were known at an early period in Persia, Greece, Rome, Egypt and other places in the Mediterranean region. For centuries sweet clover has been growing throughout Europe, from whence it seems to have been first introduced into this country, although some was brought from Chile in South America, the continent from which we also obtained alfalfa. The white sweet clover has generally been called Bokhara (bō-kä'-rā) Clover because it was supposed to have originated or was well established in a little country of that name in Central Asia, situated just west of Chinese Turkestan and east of the trans-Caspian territory of Russia. This region consists principally of desert and mountain ranges devoted largely to raising goats, sheep and cattle, and possesses a climate of unusual severity—of cold in winter and heat and drouth in summer. Except in Bokhara, the early accounts of sweet clover do not seem to have distinguished between the various kinds, and not until it reached Europe have we found separate mention of the biennial yellow kind.

3. Distribution.—Sweet clover is grown as a farm crop in Europe, India, China, Australia, and to some extent in Siberia. In South America it is found growing in many places, but is utilized there mainly for grazing. In North America it was known in Virginia as early as the colonial period, and is now

to be found in Canada, Mexico and in each of the United States. Perhaps no other forage plant has a wider distribution throughout the world.

4. **Climate.**—The hardiness of sweet clover enables it to thrive in practically all climates, from sub-tropic to the farthest northern latitudes where agriculture is pursued; and its well known ability to withstand severe droughts enables it to establish itself in semi-arid and even in arid regions with a total annual rainfall of less than 11 inches, where other crops can not be grown without irrigation. It grows at sea level and at elevations of 8,000 feet in this country, and has been found growing at 13,000 feet above sea level in the Himalayas.

5. **Soils.**—In practically every well known type of soil, from the heaviest clays to very light sandy soils, including clay loams, sandy loams, hardpan, gravelly and stony soils, sweet clover is found growing successfully. It makes good growths in soils too wet and in soils too dry for red clover and alfalfa; will grow better than either of these in acid soils, but soils that are not acid and which contain plenty of lime produce better yields. Sweet clover is able to grow in strong alkali soils, and on very poor, hard and rough ground devoid of humus, where other clovers will neither thrive nor make a start.

6. **Uses.**—Sweet clover is utilized for improving the soil, as food for livestock, as a seed crop, and for bee pasture. In different countries it is also used for such additional purposes as a "pot herb" for human food, as a flavoring in the manufacture of cheese, as a substitute for vanilla flavoring and in the preparation of medicines and perfumes.

7. **Eradication.**—The biennial sweet clovers are easily eradicated by preventing them from maturing seed. This is usually done by mowing while in full bloom; and as they do not spread from the roots they are effectively killed out. The plant has no tendency to spread into cultivated fields, nor will it persist in alfalfa meadows, as the frequent mowings prevent seeding. The annual or Indian Sweet Clover is sometimes troublesome in grain fields where it matures its seed by harvest time; but the biennials are more easily controlled than red clover or alfalfa.

8. **Plant Enemies.**—This forage plant seems peculiarly free from injury by insects and parasitic plant diseases. In a few instances the clover root corculio has been found on sweet clover, and leaf spot has been observed; but practically no damage has resulted from these. The writer has never observed or heard of dodder infesting sweet clover; but field mice have been known to feed on the large "fleshy" roots to some extent in winter.

9. **Plant Improvement.**—Some work has been undertaken with sweet clover by several agricultural experiment stations in the way of plant improvement, principally to secure strains with a larger proportion of leaves and fine branches, and to eliminate some of the bitter element due to the cumarin it contains. In Northern Kentucky marked improvement has been made with sweet clover in the last twenty-five years in palatability and increased vigor, and quality or texture of the forage produced, which are attributed to the plant having been grown there for a long time as a cultivated farm crop. But such improvements as these should not be confused with the claims of some heralding so-called new strains of sweet clover which exist in imagination more than

actuality. The main characteristics of the several kinds of sweet clover seem to be well fixed, and no great changes are likely to be effected.

10. Principal Kinds Compared.—White: The white sweet clover makes a larger and ranker growth and furnishes more humus than any of the others. Its stems are coarse and often reach a height of 11 feet. It seeds abundantly, but ripens unevenly, so that the yield is less than that of the biennial yellow. The nutritive value of the forage is equal to alfalfa except for the rather high percentage of crude fibre in the large stems. In humid sections some difficulty is experienced in curing the hay from white sweet clover, as the leaves dry and tend to shatter off before the stems are cured enough to put up.

Biennial Yellow: This kind of sweet clover ripens about three weeks earlier than the white, and for this reason can be grown farther north and at higher altitudes. It does not grow so tall and coarse as the white and furnishes a little less humus. There is a larger proportion of leaves and fine branches, and it makes hay of a finer texture which is more easily cured. It is more palatable, contains less crude fibre, and therefore is more digestible. When it and the white are growing in the same pasture, stock will graze down the yellow before eating the white. The nutritive value of the forage is equal to or better than alfalfa, as it contains by some analyses larger percentages of both protein and fat, and not any more crude fibre. The amount of seed produced by the yellow is about the same as that of the white, but it ripens uniformly and a larger yield is thus obtained. The seed crop can easily be handled by the ordinary wheat binder and the self-rake reaper, as it grows to about the same height as rye. The white and the biennial yellow produce about the same amount of nitrogen for the soil, but some farmers claim better results with corn and small grain after the yellow sweet clover. It is the biennial yellow that is mostly grown in Europe as a field crop, and is a more general purpose clover than the white, but it is not yet so generally distributed or so well known in this country.

Indian Sweet Clover: This clover is a small, dwarfish and spindling annual that ripens its seed early in the summer and then dies, but in warm climates it makes a fairly good green manure and orchard cover crop. In temperate latitudes it does not make sufficient growth to justify sowing, and stock are little disposed to graze it on account of its strong odor and bitter taste.

PART II

HOW SWEET CLOVER IS UTILIZED.

FOR SOIL IMPROVEMENT.

11. **Legume Crops.**—The serious drain upon the fertility of even our best farming lands by continuous cropping makes it necessary to supply liberal quantities of nitrogen and humus and to renovate and build up the soil so as to obtain profitable yields. This can be done best by growing a hardy legume crop such as sweet clover; and on poor or run-down soils there is no other plant that will serve the purpose as well. On rough lands and in neglected or eroded fields it is peculiarly adapted for the purpose of restoring them to usefulness and enhancing their value for farming purposes. With such standard farm crops of this country as corn, wheat, oats, tobacco, etc., it has been found that the yields are greatly increased after sweet clover, in many instances from 50 to 100 per cent., and in some cases even greater.

12. **Nitrogen.**—No other legume will equal sweet clover in supplying nitrogen for the enrichment of the soil. Not only the tops are quite rich in this element, but the roots afford the most favorable conditions for activity of the nitrogen fixing bacteria, as it inoculates readily and the bacteria apparently perform their functions better on the roots of sweet clover than on alfalfa or red clover, especially in soils that are acid or poorly drained. At the Illinois Experiment Station there was found to be 228 pounds of nitrogen in 12,778 pounds (6.4 tons) of dry matter consisting of tops, roots and stubble produced on one acre; as much nitrogen as would be furnished by 25 tons of average farm manure. Frequently sweet clover produces 6 to 8 tons of hay per acre besides the roots and stubble; and with such yields the total nitrogen produced by sweet clover on one acre might easily reach 400 to 500 pounds. The Delaware Experiment Station found the nitrogen produced per acre by other legumes to be as follows: Soy beans, 140.2 pounds; crimson clover, 134.4 pounds; vetch, 121.2 pounds; red clover, 102 pounds; alfalfa, 95.2 pounds; cow peas, 69.5 pounds. The amount of nitrogen in the average complete fertilizer varies from 16.4 to 33.6 pounds per ton for high priced goods, and from 8.2 to 16.4 pounds for low priced complete fertilizers.

13. **Humus.**—On account of its enormous growth, sweet clover adds great amounts of humus to the soil; and with the biennial kinds the entire crop of tops and the large, fleshy roots decay quickly and become part of the soil. It was estimated by a professor at one of our agricultural experiment stations that in a field of sweet clover 12 to 14 inches high, that was plowed under in the spring for corn planting, there were thirty-two tons per acre of green manure that went under in the form of roots, stems and leaves. A full season's growth would probably have made 50 to 60 tons. The weight of the roots alone has been found to be 20 tons per acre in some instances, and at an experiment station in Canada 30 tons of green feed have been cut from one acre.

14. Rotation Crop.—The biennial sweet clovers serve a very useful purpose as rotation crops, either for short or longer rotations. Annual plants are liable to reseed the ground when not wanted, and perennials such as alfalfa are hard to plow up, while the roots of sweet clover are soft and “fleshy” and decay completely the second year soon after maturing the plant. It may be used in rotation with corn, small grain, tobacco, cotton, rice, cane, kaffir or broom corn; and on account of the great amounts of humus and nitrogen furnished to the soil, better results are obtained with succeeding crops than after other legumes.

15. Green Manure Crop.—As sweet clover excels in producing humus and nitrogen, the two things needed on the greater number of farms, and has the ability to grow in all kinds and conditions of soil, its usefulness as a green manure crop is not equaled by any other. It is more effective in fertilizing the ground than any reasonable amount of either stable manure or commercial fertilizer. The soil retains moisture better after sweet clover than after any other crop, due to the large amount of humus produced and to the roots leaving openings in the soil and subsoil for the penetration and storage of water.

16. Winter Cover Crop.—In Northern Kentucky sweet clover continues green and growing until the temperature drops to within five or ten degrees above zero, while alfalfa is cut down to the ground at twenty degrees. A little farther south it will continue green all winter. The ability of sweet clover to resist frost, together with its rank growth, makes it an ideal winter cover crop which can be plowed under the following spring for other crops, and also afford good winter grazing, as well as preventing erosion and loss of valuable plant food from the soil by leaching out with winter rains.

17. Orchard Cover Crop.—Hardly any other crop serves as well for this purpose, as it furnishes humus and nitrogen in abundance, shades the ground so as to prevent drying out too much, and prevents erosion. Both nurserymen and orchardists, including many large commercial orchards, are now using sweet clover as a cover crop, and in California and Arizona it has been used extensively for this purpose a number of years.

18. Preventing Erosion.—Much of the enormous loss in soil fertility through erosion while the ground is idle and bare or from heavy sporadic downpours could be prevented by the use of some crop such as sweet clover. Its dense, rank growth will effectively stop washing, and the addition of such great quantities of humus and the openings made in the soil and subsoil by the large roots will enable the soil to absorb and hold more water and render it less liable to erosion. Stopping erosion was one of the first uses made of sweet clover on the hill lands of Northern Kentucky. There it was sown during the winter on deeply gullied hill lands, and its rank growth of stems and leaves falling into the gullies soon filled and leveled them up by catching the silt as it washed down the hillsides.

19. Soil Renovator.—The general condition of soils is greatly improved in a short time with sweet clover, and at less cost than by any other means. The great amount of humus produced is particularly beneficial to heavy, compact and refractory soils, making them loose and friable; and the large quantity of nitrogen added renders the soil fertile. The large roots penetrating deeply

into the soil and subsoil break up and loosen the hard layers and lower strata, and, after decaying, there is afforded better ventilation and drainage as well as storage of moisture for use of crops in the dryer parts of the season. The roots also bring up to the surface from the lower levels such mineral plant foods as potash, phosphorus and calcium and deposit them within the reach of roots of the ordinary crops—thus acting as an efficient subsoiler. Heavy clay soils are made loose and mellow, and light sandy soils have been converted into loamy soils by the addition of the large amount of humus.

20. Preparation for Alfalfa.—As sweet clover has the same species of nitrogen producing bacteria on its roots as alfalfa, and as the bacteria seem to become established quicker on the roots of sweet clover than on alfalfa, the former is much used in preparing land for alfalfa. Not only is the ground thoroughly inoculated by sweet clover, but it is supplied with humus and put in good fertile condition for growing alfalfa successfully.

21. Choking Weeds.—Sweet clover is also one of the most successful “smother” crops, as there are very few weeds that can survive in a good stand of sweet clover, especially the second season’s growth, which comes on early from the root crowns. It serves this purpose very effectively in preparing ground for alfalfa and for seeding permanent pastures.

22. Increasing Land Values.—In Northern Kentucky the increase in land values due to sweet clover is very much like romance. Lands that had been abandoned and thought to be of no value for farming, have been restored to fertility within a few years and are now producing profitably. When it was discovered that by sowing sweet clover on old, washed hill lands they could soon be restored to fertility, the gullies leveled up, and a good profit made each year from the hay, pasture and seed crop during the period of restoration, then these lands were much sought after, and prices increased rapidly, sometimes five to eight fold on some farms within five years. Many farmers from different counties and from other states have purchased lands in the sweet clover section of Northern Kentucky, and each season there are numerous visitors from nearly all parts of the country to see a demonstration of what sweet clover has done and is doing now in that section.

AS FOOD FOR LIVESTOCK.

23. Useful Forage Crop.—Sweet clover is now used extensively as food for livestock in many sections of the country, and its use for this purpose is rapidly increasing as it becomes better known. Its high nutritive value, large yield, hardiness and adaptability to a great variety of soils and climates render it capable of becoming almost a universal forage crop. It will not take the place of alfalfa as a hay crop where the latter can be grown successfully, but sweet clover is better suited for grazing, as it seldom ever causes bloat, affords more pasturage, stands grazing without injury, produces excellent feed in abundance, and can be grown in many soils that will not produce alfalfa.

24. Nutritive Value.—This is determined by chemical analysis, feeding tests and actual trials on the farm; and in these instances sweet clover has proven the equal of alfalfa and even superior in some cases. In the analysis of forage plants the results will vary considerably due to time of cutting,

manner of curing and handling, and other causes, all of which should be considered. The majority of analyses show sweet clover to have as high or higher percentages of protein than alfalfa, and considerably more fat.

CHEMICAL ANALYSIS.—In Kentucky Bulletin 178 is given the following amounts of protein in 100 pounds of various feeds, taken from Henry's "Feeds and Feeding": Sweet clover, 18.0 pounds; alfalfa, 16.3 pounds; wheat bran, 15.4 pounds; soy bean hay, 14.9 pounds; alsike, 12.8 pounds; red clover, 12.3 pounds; orchard grass, 8.1 pounds; redtop, 7.9 pounds, and timothy, 6.0 pounds.

The following analyses were made by the Wyoming Experiment Station of sweet clover and alfalfa grown on the experimental farm:

	SWEET CLOVER.		ALFALFA.
	Cut Aug. 10, 1905	Cut Oct. 4, 1904.	Average of 11 Samples.
	Per Cent.	Per Cent.	Per Cent.
Water	6.88	6.02	6.57
Ash	11.03	9.57	8.79
Ether extract (fat).....	1.96	2.42	1.66
Crude fibre	22.27	21.77	31.25
Crude protein	22.19	18.00	15.14
Nitrogen—free extract	35.67	42.22	36.59

The Massachusetts Experiment Station reports the amount of protein in sweet clover by analysis of second year's growth at different stages as follows: 30 inches high, 23.37 per cent.; 36 inches high, 18.62 per cent.; 45 inches high, 17.18 per cent.

The Mississippi Experiment Station reports the amount of protein in sweet clover by similar analyses as follows: Cut in May, 22.96 per cent.; four samples cut in June, varying as follows—30.54 per cent., 20.19 per cent., 17.85 per cent., and 15.20 per cent.; cut in August, 18.32 per cent.; cut in October, 19.45 per cent.

FEEDING TESTS.—At the Wyoming Experiment Station lambs were fed fourteen weeks, with average gains per head as follows: On alfalfa, 34.4 pounds; on sweet clover, 30.7 pounds, and on prairie hay, 20.3 pounds. The report (Bulletin 80) states that the sweet clover hay "was cut late and was very coarse and stemmy. The lambs liked it, however, and showed a steady appetite for it. There was not the slightest difficulty in getting them to eat it at the start." It might be noted that the sweet clover hay used was not in good condition, and that by analysis contained only 15.74 per cent. protein as against 22.19 per cent. protein in a crop of sweet clover hay cut August 10th on the same farm. This condition of the sweet clover hay may account partly for the alfalfa lambs making larger gains.

At the South Dakota Experiment Station another feeding test was made with lambs, using alfalfa, sweet clover, field pea hay, shredded corn fodder, prairie hay and corn silage. The report, in Bulletin 143, states: "The gains [with sweet clover] were unequaled only by the lots that received alfalfa hay. The gains for the lot were comparatively uniform, the hay palatable, and from the results we believe it should be considered one of the principal crops in a system of livestock farming."

A comparative grazing test with young shoats was conducted at the Iowa Experiment Station in 1909, 1910 and 1911 by pasturing on alfalfa, biennial yellow sweet clover, red clover and various other forage plants. In Bulletin 136 the report states that the largest daily gains, with lowest cost per pound and greatest profit per acre, were made on the alfalfa pasture, with biennial yellow sweet clover and red clover close seconds, which were about equal, and superior to all others excepting alfalfa. The average cost per hundred pounds of pork was, with alfalfa, \$4.03, sweet clover \$4.21, and red clover \$4.37. In one season the largest profit per acre on alfalfa was \$97.09; on biennial yellow sweet clover, \$74.50; on red clover, \$64.55; and the largest daily gain on alfalfa was 1.048 pounds; on biennial sweet clover, 1.022 pounds; and on red clover, 1.132 pounds.

PRACTICAL FEEDING.—The high nutritive value of sweet clover as hay and pasturage is fully borne out by the experience of numerous farmers, dairymen and stockmen throughout the country. Cows produce 20 to 33 per cent. more milk on sweet clover than on alfalfa, and beef cattle are being turned off fat from sweet clover pastures that bring a premium on the Chicago market of one cent per pound over ordinary grass-pastured stock. In Northern Kentucky the fattest lambs and best butcher steers sent to the market are from the sweet clover pastures, and there a large dairying industry is carried on with cows pastured on sweet clover in summer and largely fed on sweet clover hay in winter. In Kansas, Utah and other western states large numbers of cattle, sheep and lambs are fed and grazed on sweet clover with highly satisfactory results in all cases; and in Iowa hogs are being grown and developed on sweet clover pastures until they are ready for finishing with corn. The many users of sweet clover for feeding livestock find it satisfactory and profitable, and prefer it to any other forage for pasture, and often prefer it to alfalfa for hay.

25. Palatability.—While owing to the peculiar odor and flavor of sweet clover, individual animals sometimes do not take to it readily at first, yet all kinds of livestock soon learn to like it and eat it greedily and thrive on it, generally preferring it to any other forage. This hesitancy in eating it applies only to the plant as pasturage or while green and usually after it grows large and coarse, for when it is cured into hay stock do not hesitate to eat it from the start, nor do they hesitate to feed upon it when young and tender. The reason for stock not always taking to sweet clover readily at the start is attributed by some to the element cumarin it possesses, but this is not certain, for the likes and dislikes of stock for certain kinds of food are generally matters of acquaintance or education. Few kinds of livestock will at first take readily to rape or ensilage. In most every section stock would not eat alfalfa at the start, and it is well known that the horses and cattle of the Western ranges would not eat corn until educated to it. That large numbers of horses, cattle, milch cows, sheep and hogs are being pastured and fed on sweet clover in many sections of the country, and that they thrive and do exceedingly well on it, are facts sufficient to eliminate any serious doubt about its palatability as food for livestock.

26. Pasture.—One acre of sweet clover will furnish as much grazing as six acres of ordinary average pasturage. An acre of second year's growth will graze twenty head of grown hogs or two to three milch cows throughout the season, and often yield a fair seed crop besides. It resists drouth remarkably well, and in very dry seasons when other grasses are dry and brown in July and August,

sweet clover is often the only green thing to be seen in the pasture. At the Cottonwood Experiment Farm in South Dakota, sweet clover made a fairly good crop with a total rainfall of 10.36 inches for the entire year. It furnishes the earliest pasture in the spring and the best late fall pasture, resisting freezes until a temperature of 5 to 10 degrees F. above zero. In addition to pasturage, a crop of hay or a crop of seed can be obtained from sweet clover the same season; and some estimate that it is worth \$100 per acre each year for pasture and hay. A professor at one of our agricultural experiment stations, in a recent letter on sweet clover hay, says: "I planted a little seed two years ago this coming spring, and last year obtained what would be in money value an enormous yield per acre from it—well above \$100." At the Iowa Experiment Station in 1910 the biennial yellow sweet clover produced \$74.50 per acre as pasturage in a feeding test with hogs. Near Topeka, Kan., one farmer pastured 30 grade Holstein milch cows from April 1st to November 1st on 10 acres of sweet clover, and it was able to reseed itself, and the next spring was in a luxuriant condition. When sown in the spring it will be ready to graze in 10 or 12 weeks, and the second season affords the earliest bit of green forage to be had. About 60 per cent sweet clover and 40 per cent. of various kinds of grasses make a well balanced mixture for permanent pastures. Keeping it grazed down well or clipping occasionally maintains a constant growth of young, tender forage. Double seeding is often practiced to advantage with the biennial sweet clovers by sowing the first, and also the second years, when there will be a succession of crops coming on. A mixture of white and biennial yellow is often sown for pasture. In northern latitudes and at high elevations the biennial yellow ought to be sown for pasture on account of it reseeding with more certainty in the short growing seasons.

27. Hay.—The yield of sweet clover hay varies considerably, depending upon the stand, soil, season, proper inoculation and whether first or second year's growth. The average yield of cured hay is from 3 to 6 tons per acre, although 8 tons and over are sometimes obtained. The first year two crops are ordinarily harvested, and may be cut any time it is large enough, but should be mowed when about 18 to 24 inches tall and with a rather high stubble, as it comes on again that season by branching out from the stem instead of from the root crown. The second year it should be mowed before blooming, preferably about the same height, and with a stubble 4 to 6 inches for the biennial yellow and about 8 inches for the white. If cut too close to the ground it will have a severe set-back and the second season many of the plants are liable to be killed. Another cutting of hay or a seed crop can be obtained later. The biennial yellow sweet clover is better suited for hay on account of its finer texture, larger proportion of leaves and fine branches, and particularly on account of it curing better.

It should be cut, cured and handled similar to alfalfa, and this will vary in different parts of the country. In the humid sections care should be taken to preserve the leaves as well as possible and prevent them getting too dry and shattering off, as they contain most of the nutriment. After wilting good, the hay may lie in windrows, or be put in small shocks, which is better, until well cured but not dry, and then stored in sheds or barns. The time required for sweet clover hay to cure is a little longer than with alfalfa, especially the white: but the time required in curing of the hay, also the cutting and handling, must

be governed to some extent by the character of season, temperature and amount of moisture at the time.

28. **Ensilage.**—Sweet clover is fed as ensilage with gratifying results, and when used in this way it may be permitted to grow until rather coarse, as the cutter and the silo will reduce the coarse stems of the white sweet clover into good ensilage even more readily than cornstalks.

29. **Soiling Crop.**—Practical tests of sweet clover as a soiling crop have often been made by farmers cutting it along roadsides to see if their stock would eat it. At an agricultural experiment station in Eastern Canada a yield of over 30 tons per acre of sweet clover was obtained as a soiling crop.

30. **Catch Crop.**—For this purpose annual plants are mostly used, as they usually make a quicker growth of forage than the biennials, but with seed treated for prompt germination, sweet clover may often be used as a catch crop, especially where fall or winter pasture or a winter cover crop is desirable, and it may also be plowed under the following spring as green manure.

BEE PASTURE.

31. Sweet clover produces more honey than any other plant we have growing in this country. It has long been a favorite with bee men, who have been instrumental in spreading it into new localities. As they bloom at different seasons, both the white and yellow should be sown for bee pasture to prolong the flow of nectar. The honey is very clear and white and of excellent flavor. It has frequently been awarded first place at national expositions and at other honey exhibits, and commands the highest prices on the market.

SEED CROP.

32. Sweet clover is an abundant seeder, and at prevailing prices the seed makes an unusually profitable crop. In addition to the seed, hay or pasture may be obtained the same season, and the straw is more valuable for feeding than corn fodder. The ordinary yields are from 6 to 10 bushels of seed per acre, and a yield of 13.2 bushels per acre was obtained at the South Dakota Experiment Station in 1913. Twelve hundred pounds of clean unhulled seed per acre have been gathered from the biennial yellow. The two biennial kinds produce about the same amount of seed, but as the white ripens unevenly, larger yields are obtained from the yellow. After ripening, the seed shatter off very readily if handled when dry, but if harvested while damp with dew or showers, they cling to the stems tightly and can not be threshed off successfully until thoroughly dry again. In humid sections of the country the crop is harvested early in the morning while the dew is on, or after a shower, and then left lying on the stubble in bunches to dry, or else in small open shocks of about three bundles each. In dryer regions where morning dews are absent and summer showers infrequent, the crop is harvested more or less green to prevent heavy losses by shattering. The cutting is done with wheat binders, grain headers, self-rake reapers and mowing machines. On rough lands where machinery can not be employed to advantage, scythes and grass hooks are also used, and some seed is gathered by stripping or shaking into sacks or vessels carried into the field. The seed should be allowed to mature and ripen well for best quality. This can be determined from inspection of the field by stripping some seed and rubbing off the hulls. When the seed are yellow, plump and firm, they are ready for

harvesting. In Northern Kentucky the biennial yellow blooms from the middle of May to in June, and the white from early in June to well into July; and there the seed of the yellow is ready to harvest the last of June, and the white about the middle or latter part of July. In the Gulf States the white sweet clover seed is gathered about the first of July, and in the Western and Northwestern States from September to the middle or latter part of October. Except in the event of heavy wind or hail storms, the seed hold on well in the fields and may be harvested within three to six weeks after ripening, when most convenient; and in some instances the seed crop has been gathered late in the fall after the first light snowfall. In fields not harvested much of the seed will be found hanging onto the stems as late as January and February following.

The seed may be threshed on a grain separator or beaten out with sticks on a sled covered with canvas, after which it is run through some kind of seed cleaner. Hulling is sometimes done with grain separators and also with red clover or alfalfa hullers, but the best results are obtained with hullers especially made for sweet clover, as they remove the close-fitting and adhering seed pods better.

If the stand is too thick, seed will be produced mostly on the top branches, thus reducing the yield and also the quality of the crop. Some farmers making a specialty of sweet clover seed place numerous colonies of honey bees on their farms to secure cross-fertilization of the seed by the bees carrying pollen from one flower to another in their quest for nectar.

PART III

CULTURAL METHODS.

SWEET CLOVER SEED.

33. Selecting the Seed.—The first important step in sowing sweet clover is the selection of good seed, which is, of course, essential to the maximum success. This involves purity, trueness to name, vitality and vigor, and adaptation of the kind sown to the uses for which it is wanted. Many failures in attempting to grow clovers, alfalfa, as well as other crops, may be accounted for along these lines.

Although sweet clover grows in every State, the seed is harvested in quantities for the market in only a few localities. Seed of the small annual or Indian sweet clover is produced principally in Arizona and Southern California, where it is saved as a by-product in threshing small grain. The seed are a little smaller than that of the biennials, have a dingy yellow color, with characteristic whitish crusts or adhesions; and as found on the market are always hulled and low in price.

The white sweet clover is produced in considerable quantities in some of the Gulf States, in a few counties in Northern Kentucky, by some farmers in the Middle West where seed production is rapidly increasing, and in Utah. Northern Kentucky produces the greater part of the biennial yellow, while some is furnished by certain parts of Colorado. Formerly most of the sweet clover seed on the markets of this country was imported, and some is still imported each year.

Ripe seed will be firm and plump, have a bright yellow color for the white, and a yellow color with a faint tint or spots of olive green for the biennial yellow. Unripe seed will have a color varying from pea green to yellowish green, according to degree of immaturity. Seed that has been heated or "mow burned" will be a dull brown, and seed that has become damp or wet and started to sprout will be enlarged and light brown or red in color.

34. Purity.—Usually sweet clover is quite free from foreign seeds, unless adulterated, as there are few weeds that can survive in sweet clover fields. Lately hulled sweet clover has been found adulterated with yellow trefoil, kidney vetch, and with alfalfa when prices of the latter are low. The biennials are sometimes adulterated with the cheaper annual sweet clover seed. The seed produced in the Gulf States mostly always contains Johnson grass, and this, with the large percentage of brown or "mow burned" seed, generally affords ready means of identification. The unhulled seed is generally quite free from adulterations, but may contain immature or damaged seed which can be discovered by rubbing the hull off of a small sample.

35. Germination.—The seed naturally possesses strong vitality and vigor and retains these qualities a number of years if properly harvested and stored, and a little aging (three to five years) will not deteriorate the seed appreciably.

In fact, the seed is better for sowing the second and third years than during the same season it is harvested. The best germination is obtained with well ripened plump seed that has not been damaged by heat or moisture. The one peculiar feature of sweet clover seed is its hardness, usually affecting 70 to 80 per cent. of the seed, and causing slow germination. This is due to the hard or impermeable coating just over the seed germ that almost excludes the moisture necessary to start the germ to growing. While this feature of the seed often proves inconvenient and also discouraging when prompt germination is desired, yet it serves a useful purpose of preserving its vitality, and in its natural state tends to prevent the seed from germinating when they fall off the stems after ripening, until the following spring. A good quality of pure sweet clover seed is generally capable of germinating 95 to 98 per cent., but in its natural condition, on account of the hard seed, usually germinates 40 to 60 per cent. in a ten days' test. Effective means have now been found to overcome the slowness of sweet clover seed to germinate, by treating the seed in several ways; and except for winter and early spring sowing the treated seed should always be sown. The most important thing in securing good stands of sweet clover is plenty of moisture during germination of the seed.

36. Unhulled or Hulled Seed.—The unhulled seed has been sown altogether in Northern Kentucky, in the Gulf States, and in other localities also to a larger extent than hulled seed. For winter and early spring sowing the unhulled seed is preferable, as the hulls assist inoculation, the seeding costs less per acre, and the rains, freezes and thaws saturate and soften the hard seed coat so that it germinates well. For late spring, summer and fall sowing some think the hulled seed germinates quicker, but it should be remembered that it is the hard coating over the seed germ that is so impervious to moisture, and not the hull, which is a thin, porous and fragile membrane that decays very quickly in the ground. Where the seeding is done with drills or similar machinery the hulled seed will often be desirable. Well cleaned unhulled seed weighs from 30 to 33 pounds per measured bushel for the white, and from 26 to 30 pounds for the biennial yellow. By custom a bushel of unhulled sweet clover seed consists of 30 pounds, while a bushel of hulled seed contains 60 pounds.

37. Treated Seed.—For some time various means have been used to facilitate germination, and in laboratory tests seed were scratched with a knife or sharp file to effect an entrance for moisture to the germ. Later, another method was developed whereby the seed was treated to a bath of sulphuric acid for 20 to 30 minutes and then washed with clean water. Both of these means were effective and caused the seed to germinate promptly, but they were not practical for field use. A bath of hot water for 20 minutes at temperature of 150 to 175 degrees F. has quickened germination effectively and proven a very practical method.

Early in the season of 1915 Prof. Hughes, of the Iowa Agricultural Experiment Station presented to the public the Ames Scarifier, a machine invented by him for treating hard seeds to secure prompt and uniform germination. This process consists of scratching or grinding off a part of the hard or impervious coating over the germ so as to admit the moisture necessary to start growth; and the treatment is applied only after the seed are hulled. Both laboratory tests and field trials with scarified seed have proven very successful, and indicate that the difficulties heretofore experienced in obtaining good germination or

uniform stands with sweet clover may be overcome by scarifying the seed. At the Iowa Experiment Station the germination of sweet clover seed was increased by this treatment from 34 per cent. to 90 and 95 per cent. These figures represent about an average of many tests there, and similar results have been obtained at other stations. In field trials at the Iowa Station and on farms reporting to that station, good stands of sweet clover with treated seed were obtained with about one-third the amount usually sown. For winter and early spring sowing the untreated seed can be used successfully, but for late spring, summer and fall sowing scarified seed should be sown to secure the most satisfactory results; and in all instances where hulled seed is used the scarified seed may be sown.

METHODS OF SOWING.

38. How Sown.—The seed may be sown by hand, also with the small hand seeders in common use, with wheelbarrow and end-gate seeders, and with the later improved seed drills and disks. The hulled seed is about the size of red clover, and the unhulled seed is a little larger than millet. The small hand seeders sow both the hulled and unhulled seed, but the larger types of seeders handle the hulled seed better. Volunteer seeding occurs where the plant is allowed to mature, and the seed gradually drop off the stems from time of ripening until February and March following. The seed are too heavy to be carried far by the wind, but on sloping ground are washed down with the rains some distance.

(Section 39 Corrected.)

39. Sowing on Top of the Ground.—In winter and early spring the seed may be sown on top of the ground, and will become covered by the rains, freezes and thaws. The moisture saturates and softens the hard coating over the seed germ and prepares it for early germination. Freezing also aids germination. Sweet clover, as well as red clover, alsike and many other kinds of seed, are usually sown in this way on wheat, rye, winter oats, and in meadows and pastures. It also permits the use and occupation with sweet clover of poor, rough, idle or washed lands that either could not be cultivated or would not be profitable to seed any other way. Sowing sweet clover seed on top of the ground has the advantage of convenience and also of economy, as no labor is required in preparing a seed bed. But this method is not well suited to southern latitudes where there is no freezing of the ground, nor to very light, sandy soils, which, on account of their drainage, do not honeycomb or work much with freezes. When sown on freshly tilled ground after last cultivation of corn, or after plowing in small grain in the fall, the seed becomes imbedded in the loose, crumbly soil, and, when followed by rains, usually gives satisfactory results.

40. Covering the Seed.—Seeds of all kind usually germinate better when covered the right depth—lightly for such small seed as clovers, alfalfa, alsike and most grass seeds. For late spring, summer and fall sowing of sweet clover it is always best to cover the seed. This may be done with a drag, disk or toothed harrow, or with one of the modern seed drills. The depth of covering should vary with the kind of soil, its mechanical condition and the amount of moisture present. In rather heavy soils, with a finely pulverized surface, one-half inch will be deep enough, but in a coarse soil or rough seed bed, in light,

sandy soils, and under dry conditions, the seed may be covered an inch or more. After the seed are covered a land roller will smooth and firm the surface of the soil so as to promote germination by bringing the soil particles in closer contact with the seed and bringing the moisture up from the subsoil by capillarity. As sweet clover seed should not be covered as deeply as grain, the latter should be sown and covered before sowing the clover seed. Late in the spring sweet clover seed may be sown on winter grain before it grows very tall, and covered with a toothed harrow. This will afford a cultivation for the grain and usually improves it very much.

In case of winter and early spring sowing of sweet clover, the ground will be in condition at times to permit covering the seed when sown, by stirring the surface with some kind of implement, and if this is done a better stand will most always be secured.

41. Double Seeding.—For pastures and meadows double seeding, by sowing two years in succession, is of advantage by reason of having first and second years' growth on the land each season. By this means a crop of hay may be cut early from the clover coming on from the roots, then a seed crop later and another hay crop the latter part of the summer from the young clover germinating in the spring; or, if used for pasture, there will be a succession of young, tender growth each year from early spring until hard freezes of the winter set in.

42. Seed Bed.—Good germination of sweet clover seed is best obtained in a seed bed that is firm or compact from the subsoil up to or near the surface; in fact, the seed will germinate very poorly in a soil that is dry and loose down very deep. In sections where rainfall is abundant during the winter and early spring the ground will naturally be compact and in good condition for germinating the seed. Where it is necessary for any reason to cultivate the soil deeply, such as breaking up sod or eradicating weeds, it should be allowed to settle well before sowing, and a few rains will usually put it in condition again. A shallow layer of finely pulverized soil on top, about two inches deep, will furnish an ideal condition for covering the seed, and this may be firmed again with a roller to good advantage after the seed is sown. Experience during dry seasons has shown that green manure crops freshly plowed under, such as cow peas, rye and clover, leave the seed bed too loose until they are well rotted, and shut off the needful supply of moisture in the subsoil. By use of scarified seed good stands may be obtained with less moisture and with the seed bed looser than with untreated seed.

TIME OF SOWING.

43. The seed may be sown any time of the year except late in the fall in localities where severe frost will follow before the young plants are well rooted. In the Southern States this exception would not apply, while in our most Northern States it would practically restrict fall sowing of sweet clover. In Iowa it may be seeded in the fall, while in Michigan the young plants winter-kill if seeding is delayed much after the first part of August. In semi-arid sections germination will not occur until there is sufficient moisture in the soil, but the sowing may be done when convenient, as the seed will remain dormant during the dry season. In Arizona and Southern California sweet clover is sown for

green manure and as an orchard cover crop in September and October, and sometimes as late as December.

In Northern Kentucky sweet clover seed is sown on wheat and rye by broadcasting on top the ground in January, February and March; also in meadows, pastures and on idle and rough lands and in washes and gullies to stop erosion. Later in the spring it is sown with oats, spring barley, with alfalfa and other clovers and grasses and also alone, but the seed is then covered with some implement. In summer and early fall it is sown alone or with alfalfa, in corn at last cultivation, on stubble land after harvest, and with small grain in the fall. Winter and early spring sowing produces early pasturage or usually two cuttings of hay the first season. Late spring sowing will make a crop of hay early in the fall. Summer and early fall sowing make good fall pasture, and have the advantage of maturing a crop of seed the next year, or may be turned under the following spring for green manure; it also allows opportunity for frequent tillage of the soil during the summer to destroy weeds where the ground is badly infested.

AMOUNT OF SEED.

44. This depends somewhat on the purpose for which it is sown and the quality of the seed. Being a biennial plant, it stools out from the root crown in the spring of the second year and becomes very much thicker on the ground than the first season—fifteen to twenty stems coming from one root, and often fifty or more. As the sweet clover plant grows much larger than alfalfa, they should not stand so thick on the ground. If the stand is too heavy, the plants will not make a normal development, and the crowding will trim the leaves and fine branches from the lower part of the stems, resulting in less hay and of inferior quality.

Fifteen pounds of unhulled or ten pounds of hulled seed per acre will make a good average seeding. Where untreated seed are used, a greater amount is recommended by some, to provide against the slow germination of the hard seed; but as a large part of sweet clover seed is naturally hard, the stand obtained depends more upon proper methods of sowing and favorable conditions as to moisture than on the quantity of seed used; for if these matters are ignored, no reasonable amount of seed could be relied upon to give a good stand. Winter sowing of untreated seed will result in better stands than by use of larger amounts of the same kind sown in spring, summer and fall; and with scarified seed sown in spring, summer and fall good stands can be obtained with less seed than required with untreated seed.

A pound of pure sweet clover seed, average quality, contains about the following number of seed (in even thousands): Unhulled white, 235,000; hulled white, 290,000; unhulled biennial yellow, 288,000; hulled biennial yellow, 310,000. The difference in size between the white and biennial yellow seed is well shown here, as well as the difference between hulled and unhulled seed.

Ten pounds of hulled seed per acre would represent about 70 to the square foot, and fifteen pounds of unhulled seed would be about 80 to the square foot. However, the amount of seed used is not determined by such nice calculations, as they can not be distributed so evenly, purity and vitality are sometimes low and a plant can not be expected from each seed sown. It is economical to sow more seed than the number of plants actually wanted on the ground, and depend

upon nature to "weed out" the surplus and weakly ones. But it is poor economy to sow so thickly that even the best plants will become much weakened in the struggle to survive among so many. A larger number of unhulled seed may be sown to the acre to allow for impurities and defective seed that are not readily observable, and a few more seed of the biennial yellow should be sown than of the white, as the plants do not grow so rank and more of them can occupy a given space of ground. For the purpose of comparison, the number of seeds in a pound of other kinds is about as follows: Alfalfa 226,000, red clover 288,000, alsike 700,000.

When the crop is to occupy the ground only one season, or is to be plowed under in the spring of the second year, twenty pounds of unhulled or twelve to fifteen pounds of hulled seed may be used per acre. For a seed crop not over five pounds seed per acre should be sown, and a like quantity sown on idle lands will give a good start, which will reseed the ground abundantly with the first crop of seed produced. Five pounds of seed makes a good combination with alfalfa, and eight to ten pounds with other grasses for meadows and pastures.

INOCULATION.

45. Unhulled sweet clover seed carries on the surface of the pods some small particles of soil from the field where it was grown and thereby helps to provide inoculation where sown. However, by this method thorough inoculation does not always occur until a year or two; and, as good inoculation is very important to the best success, it is usually advisable to inoculate artificially with either soil or pure bacteria culture. Three to four hundred pounds of inoculated soil per acre, taken from where sweet clover, alfalfa, burr clover or trefoil are growing successfully with inoculation, and spread evenly over the ground and harrowed in, will usually do the work. Fifty pounds run through the fertilizer attachment of a seed drill will also prove quite satisfactory. A gallon of well inoculated soil sifted over a bushel of seed that has been moistened with a weak solution of glue and water to cause the soil particles to adhere to the seed, and then thoroughly mixed, will give inoculation. But, as the soil method may introduce noxious weeds or fungous soil diseases, and as the soil itself may not always be well inoculated, it is generally safer as well as more convenient and economical to use pure bacteria culture, which is applied directly to the seed just before sowing, and which can now be obtained at a very reasonable cost.

The bacteria are destroyed by the direct rays of strong sunlight in a few hours, and with both soil and pure culture inoculation the seed should be covered or the inoculated soil worked into the ground. This work may be done to advantage on a cloudy day or late in the afternoon. For winter or early spring sowing the bacteria culture may be applied and the seed sown on top of the ground, when the bacteria will become covered gradually with the seed. The actinic or chemical rays of the sun are not so strong then as later toward the summer and will not kill the bacteria. Freezing does not affect the bacteria, either in the soil or in pure cultures.

NURSE CROP.

46. A nurse crop is not required for sweet clover, and in fact it does better without one; but often it is desired to raise a crop of grain while the clover is coming on. Barley and rye are less injurious to the young clover than wheat or oats; the latter especially shade the ground and draw heavily on the supply of moisture in the soil.

TRANSPLANTING.

47. Sweet clover may be transplanted with either seedlings of the first season's growth or with heavier roots of the preceding year. Seedlings may be transplanted at any time, even in midsummer during protracted droughts, but the tops should then be pruned back a little. The large roots are transplanted best while dormant or quite early in the spring or in the fall. This is a very good method of planting sweet clover for a seed crop and also to introduce the plant into new localities, and if the roots already contain bacteria no further inoculation will be required. The plants should be set in rows about three and a half feet apart each way, which will permit cultivation and produce a maximum crop of seed.

LIME AND FERTILIZERS.

48. **Lime.**—The frequent recommendations of the use of lime on the farm has, perhaps, resulted in some confusion as to its functions; and the reading of some articles on sweet clover would lead one to believe the most suitable place to grow it would be in a lime kiln. While lime is one of the essential elements of plant food, yet the amount required by most plants is so very small that there are few soils in which it is lacking to the extent that any additional supply is needed for that purpose. Three ways in which lime may be beneficial are as follows: First, in decomposing stored mineral substances, especially potash, and rendering that element and phosphorus more available as plant food; and in decomposing organic matter, which is the source of much of the nitrogen content of the soil. In this way lime acts as a stimulus rather than adding new material as plant food. Secondly, by improving the mechanical condition of the soil, making it mellow and more responsive to the influences of soil water, and air. These beneficial effects are particularly noticeable in heavy or clay soils. Thirdly, by correcting an excess of acidity in some soils, and rendering conditions more favorable for the work of nitrogen-gathering bacteria.

Clovers and alfalfa utilize somewhat more lime as plant food than other forage crops, but the assertion often made that they are "lime-loving" plants should be taken more properly to mean that the lime improves the chemical and mechanical conditions of the soil and renders it more suitable for the work of nitrogen-fixing bacteria, thus promoting healthy growth of these plants by aiding in developing the requisite nitrogen.

Sweet clover is benefited by lime and makes its best growth in soils well supplied with it, but it is not so dependent upon lime as alfalfa or red clover, and is more or less tolerant of acid conditions. To advise liming the soil wherever sweet clover is sown often entails an unnecessary expense; and the representation that sweet clover will not grow unless the soil is rich in lime is contradicted in practically every State by the many splendid growths of the

plant on soils known to be acid. The hill lands of Northern Kentucky are largely acid on the ridges and on the upper third of the hillsides, yet sweet clover crops are grown so tall and rank there on these soils that one could not ride through them on horseback.

The principal forms of lime for agricultural uses are raw ground limestone and burned lime. The latter may be hydrated or else "lump" or "quick" lime. Calcium is the element in lime that neutralizes acidity and furnishes plant food. A ton of ground raw limestone of average good quality contains 800 pounds of calcium; a ton of hydrated lime, 1,080 pounds; and a ton of fresh burned "lump" or "quick" lime contains 1,420 pounds of calcium. It will be seen that a ton of "quick" lime is almost equal to two tons of raw ground limestone, but when the latter is accessible at reasonable cost it is generally better to use, and more economical, as it can be applied to the soil at any time, and in any reasonable amount without injury to the soil or crops. It becomes available slowly, but may be applied in larger quantities and less often. According to the degree of acidity and nature of the soil, from one to five tons of raw ground limestone may be applied per acre, one-half to three tons of hydrated lime, and a fourth to one ton of "quick" lime. The "quick" lime on account of its caustic properties might injure crops if applied too heavily, and both it and the hydrated lime may leach out with the soil waters and become wasted if applied in excess. More lime may be applied with good results on heavy clay soils than would be advisable for light sandy soils; and the frequency of applications depend somewhat upon the kind of soil, number and kinds of crops, amount of rainfall, and to some extent whether the soil has a winter cover crop to prevent excessive leaching out of the lime.

49. **Fertilizers.**—The well known ability of sweet clover to grow in old worn and poor soils renders the use of fertilizers of less importance than in case of alfalfa. Stable manure is particularly good in getting a start under adverse conditions, and in peat and muck soils, and in some light sandy soils, potash may often be applied with good results. Tired soils that have been used regularly for grain crops, will generally be benefited by the application of about 200 pounds or more of acid phosphate; and in sour soils either stable manure or some form of nitrogen fertilizer, such as Chile saltpeter or guano, may be used to give the plant a start while the nitrogen-fixing bacteria are developing. The amount and kind of fertilizers that may be helpful will depend largely upon the soil and local conditions, which can be understood better as a rule by those who are familiar with them.

PASTURES AND MEADOWS.

50. **Pastures.**—Clovers and grasses should be sown together for pasture, as clovers have the power to provide nitrogen, which is used by the grasses as plant food. A mixture will afford more and better grazing, and at the same time be safer for cattle, as the clovers will then be less liable to cause bloat. Pastures containing mixed grasses and clovers maturing at different times furnish a succession of green forage throughout the season. The several kinds, having different habits and requirements, seek their food at varying levels in the soil and thus grow and flourish together without detriment to each other. They also form a dense sod that chokes out the weeds and holds the moisture in

the soil. A number of clovers and a variety of grasses may be seeded together for pastures to good advantage, thus utilizing the low, the wet, and the shady places, as well as the thin, poor points and uplands, with the varieties best adapted. Such pastures will provide grazing for the early spring, for the hot summer weather and for the late fall, as well as for the wet and occasional droughty seasons. Below is suggested a mixture for pastures well adapted to medium soils and to localities from Tennessee north and east, and west to the semi-arid regions lying east of the Rocky Mountains:

5 pounds White Sweet Clover,	3 pounds Timothy,
5 pounds Biennial Yellow Sweet Clover,	2 pounds Redtop,
1 pound Alsike,	3 pounds Meadow Fescue,
1 pound Mammoth Clover,	3 pounds Italian Rye Grass,
4 pounds Kentucky Bluegrass,	3 pounds Tall Oat Grass.

In thin, poor soils and those lacking in lime, orchard grass and more redtop may be substituted for Kentucky bluegrass. In wet soils alsike and sweet clover do better than mammoth clover, and there redtop may take the place of Kentucky bluegrass. In dry sections of the West and Northwest, *Bromis inermis*, meadow fescue and the native prairie grasses would suit better than Kentucky bluegrass and timothy, and more sweet clover should be added in place of the mammoth and white clovers. Orchard grass makes splendid pasture and is well adapted to poor, dry and acid soils, but if combined with Kentucky bluegrass it will eventually supersede the latter. For woodland pastures, Kentucky bluegrass, orchard grass, tall meadow oat grass, wood meadow grass and Japan and sweet clover are advised. In the southern parts of the country, sweet clover, Japan and burr clover may be combined with Bermuda, carpet grass, redtop and orchard grass. Space will not permit further enumeration of the many other good forage plants that may be used for pasture, but more could be added in most all cases to good advantage and many other combinations arranged to suit particular needs.

51. Meadows.—Such clovers and grasses should be combined for meadows as will mature and be ready for mowing about the same time, and it is also desirable to have such as will grow nearly the same height. In other respects the suggestions as to pasture mixtures apply in the main to meadows. As sweet clover may be cut for hay the first season any time it is large enough, it combines readily with most clovers and grasses for meadows. The second season it should be mowed for hay before blooming (and with a high stubble), and the second cutting will come on again in about the same time required for other meadow grasses and clovers. Sweet clover may be combined with alfalfa, alsike, mammoth clover, and with timothy, orchard grass, redtop, meadow fescue, tall oat grass, *Bromus inermis* and many others, according to the character of soil and climatic conditions. With meadows as well as pastures, grasses are more or less competitors with each other for the food supply and moisture in the soil, and in like manner clovers compete with other clovers, except for certain variations such as root growth and time of maturing; but clovers and grasses grow together in the same soil more or less in harmony. In forming combinations for seeding the grass seeds should be proportioned with the several other grasses used, and the clovers proportioned with the other clovers; but nearly

the full amount of clover seed and of grass seed may be used as where each is sown independently.

The following combinations with sweet clover are suggested for use in meadows:

Clover Meadows.

ALFALFA:

15 pounds Alfalfa
5 pounds Sweet Clover

MIXED CLOVERS:

3 pounds Alsike
8 pounds Sweet Clover
4 pounds Mammoth Clover

CLOVERS AND ALFALFA:

8 pounds Sweet Clover
3 pounds Mammoth Clover
3 pounds Alfalfa
1 pound Alsike

Mixed Clovers and Grasses.

GOOD SOILS:

5 pounds Timothy
8 pounds Sweet Clover
10 pounds Meadow Fescue

MEDIUM SOILS:

5 pounds Timothy
3 pounds Redtop or 8 pounds Tall
Meadow Oat grass
10 pounds Sweet Clover

WET OR ACID SOILS:

8 pounds Orchard grass
8 pounds Sweet Clover
3 pounds Redtop
2 pounds Alsike

The sweet clover in the above meadow mixtures refers to the biennial yellow, which is more suitable for hay; and the quantity indicated for meadows and pastures is for unhulled seed, but if hulled seed is used the quantity may, in one's discretion, be reduced slightly. Other combinations to suit local conditions and particular needs may be arranged with the many other varieties of good meadow forage plants.

The mixed forage for pasture or for hay is decidedly better for livestock than either clovers or grasses alone, and stock will relish and do much better on the mixtures, as they furnish a more balanced ration, are more palatable and help keep the animal in good condition. For beef cattle, sheep and young growing animals of all kinds a mixture of 60 per cent. clovers and 40 per cent. grasses furnishes excellent forage. For milch cows, 75 per cent. clovers and 25 per cent. grasses is better when used with the usual silo, grain or mill feed ration; while 50 per cent. each of clovers and grasses is better for work horses and mules.

It is well known that some meadow and pasture crops attain their best development within a few years after being sown, and then go back; while some do not reach their best periods until about the time the other kinds are in their decline. Among the former are timothy, bermuda grass and awnless brome grass; while Kentucky bluegrass, meadow fescue and meadow foxtail are among the latter. In some sections alfalfa meadows remain productive only four to six years, though for a longer period in many parts of the country. Sweet clover fields are known to last twenty-five years, but better results are obtained by breaking up the field every five to seven years. Meadows composed mainly of grasses may be greatly improved and the yield of hay increased by alternating occasionally with a clover crop or with mixed crops of clovers and grasses.

CONCLUSION.

While endeavoring to arrive at a fair estimate of the value and merits of sweet clover on the farm, one is likely to encounter differences of opinion, for some may be prejudiced against it from its early history as a weed, some may have expected too much from it and are disappointed, a few have tried and failed to get it to grow, while others, having had more or less success, become over-enthusiastic in praise of its merits. The truth is, we have no one plant that fulfills all the requirements of an ideal forage crop. The greatest one is, perhaps, alfalfa, but it is rather a particular chooser of soils and climates, requires special tillage, inoculates slowly and then is often uncertain. Alfalfa will not stand close grazing, has numerous insect and other plant enemies, and is not the best adapted for rotations and soil renovation.

Strangely enough, in the onward march of our great agricultural development, until recent years there has been little attention given to alfalfa's first cousin, sweet clover, and consequently there are comparatively few farmers acquainted with its character and merits as a farm crop. That it is rich in food value, grows luxuriantly, stands grazing without injury, and thrives in a great variety of soils and climates; that it inoculates readily, is a great soil builder and has few plant enemies, are enough to make it all but the greatest of leguminous forage crops, certainly next to alfalfa; and in some localities and soils where alfalfa will not succeed, there sweet clover will have no superior. As it becomes better known, it will come to have a more prominent place in our agriculture, in feeding, crop rotation and soil renovation, and as stock raising and dairying increase, its place will become more and more important.

Some of us little realize the great importance of our forage plants in American agriculture, and many practice farming as though the plow and the hoe were the only producers of values. The truth is, that our forage plants are of far more value than any other product of the farm. According to the United States Census our corn crop has the greatest money value of any single crop enumerated, with the harvested crop of hay and forage, second, and ahead of wheat, oats, rye, tobacco and rice. When the value of our grazed crop from the pastures is added to the hay crop, then our forage crop will far exceed any other in this country and stand pre-eminently the greatest product of our agriculture; and this does not take into consideration the great and important use of the forage crops for soil improvement. The profits from beef, pork, mutton, the dairy, and from poultry, all come from the pasture rather than from the corn crib or granary. If our forage plants dried up or failed for "even a single year, famine would depopulate the world."

Truly the gift of the green herbage, spreading out under our feet in its beauty and freshness, to adorn the earth and provide sustenance for man and beast, is the greatest and best boon of Providence. This was the foundation of the first primitive agriculture, and is yet the dependence, the hope, and the profit of our best farming.

APPENDIX.

TESTING SWEET CLOVER SEED BY THE ACID TREATMENT.

On account of the hard and impervious coating over the germ of sweet clover seed, the ordinary methods of testing field seeds will not give reliable results as to vitality; and even when the test is extended over a period of six to eight weeks with untreated seed, some hard ones will remain unsprouted, although these are capable of germinating and making vigorous plants, especially when sown in winter or early spring. The winter and spring rains saturate and soften the hard coating over the germ so as to permit early germination, and freezes materially promote the same results.

By the acid treatment reliable results can be obtained in from two to four days, sufficient for practical purposes, and by extending the test entirely accurate results can be secured in a comparatively short time. This method of testing sweet clover seed as well as red clover, alfalfa and other leguminous seeds, is used by the United States Department of Agriculture and by many State Experiment Stations and Agricultural Colleges. The test can be made easily by anyone, and will be interesting and often very useful on the farm. The acid treatment should not be applied to scarified seed, as the hard seed coat having partially been removed by that process, the acid would quickly penetrate into the germ and kill it.

Directions.—Purchase a few ounces of chemically pure sulphuric acid. Take a small quantity of seed and, if unhulled, rub the hull off, and, after blowing out the dust and chaff, put the seed in a small cup or glass, or glass tube, and pour enough acid on to cover or float the seed. Stir a little so the entire surface of the seed will come in contact with the acid, and let stand twenty to thirty minutes. Next pour on enough water to thoroughly dilute the acid, and then drain off and, after thoroughly washing with clean water, place them between two damp blotters or pieces of soft cotton and put in a saucer with another saucer inverted over it as a cover. Put in a warm place and keep the blotter well dampened, but not so as to cover the seed with water, as they require some air in order to germinate. In about two days a majority of the seed will have germinated. Remove these seed and count them, and, after adding sufficient water, put the saucer again in a warm place. In the next twenty-four to thirty-six hours 85. to 95 per cent. or more of the seed will have germinated. Among the seed remaining unsprouted some will be extra hard. Give them another bath in the acid for fifteen or twenty minutes, remove and wash with clean water as before, and place in saucer again. If it is desired to carry out the test further, practically all the seed can be germinated. The dead seed will turn soft and show signs of decay, while the sound ones will remain firm and plump until they yield under the acid treatment to the effects of heat and moisture and finally germinate.

One hundred seed will be a convenient number to use in the test, and the number germinating will be the percentage. For accurate results it is better to remove all foreign seed that may be found, as well as cracked, immature or undeveloped seed and count them as impurities, as the latter could not be expected to germinate. The sprouting of any red clover, alfalfa, trefoil, or other

foreign seed that may have been used for adulterating, would be misleading if counted with the sweet clover seed.

During the test the seed should not be subjected to a heat of over 90 degrees Fahrenheit, and at night the temperature may fall gradually to 30 or 40 degrees, thus causing the contraction or expansion of the shell over the germs, which nature provides when the seed are sown in the ground during the winter or early spring months. But in tests for germination prompt results are generally desired, and the temperature should be maintained all the time as near about 85 degrees as practicable.

Caution.—Sulphuric acid is a strong corrosive that will burn organic matter and some metals that it comes in contact with. Mixing of the acid with a similar quantity of water creates a sudden and intense heat. When ready to remove the seed from the acid, dilute it with four or five times as much water and pour off the mixture at once. In the pure acid the seed float on top, but when sufficient water is added they settle at the bottom of the vessel, and they can be washed easily several times and the water drained off. The blotters used in making this test should first be washed freely to remove any harmful chemicals used in the manufacture of the paper.

